August 13, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Supplemental Response to NRC Request for Additional Information No. 326 (eRAI No. 9266) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 326 (eRAI No. 9266)," dated January 08, 2018
2. NuScale Power, LLC Response to NRC "Request for Additional Information No. 326 (eRAI No.9266)," dated February 27, 2018

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) supplemental response to the referenced NRC Request for Additional Information (RAI).

The Enclosure to this letter contains NuScale's supplemental response to the following RAI Question from NRC eRAI No. 9266:

- 12.02-12

This letter and the enclosed response make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Carrie Fosaaen at 541-452-7126 or at cfosaaen@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

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Enclosure 1: NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9266

Enclosure 1:

NuScale Supplemental Response to NRC Request for Additional Information eRAI No. 9266

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Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 9266
Date of RAI Issue: 01/08/2018

NRC Question No.: 12.02-12
Regulatory Basis

10 CFR 52.47(a)(5) requires applicants to identify the kinds and quantities of radioactive materials expected to be produced during operation and the means for controlling and limiting radiation exposures within the limits set forth in 10 CFR Part 20.

10 CFR 20.1101(b) and 10 CFR 20.1003, require the use of engineering controls to maintain exposures to radiation as far below the dose limits in 10 CFR 20 as is practical. The requirements of 10 CFR 20.1204, "Determination of Internal Exposure"; 10 CFR 20.1701, "Use of Process or Other Engineering Controls"; and 10 CFR 20.1702, "Use of Other Controls," specify the use of design features such as the use of ventilation for controlling the intake of radioactive materials. NuScale DSRS section 12.2, "Radiation Source," regarding the identification of isotopes and the methods, models and assumptions used to determine dose rates. The Acceptance Criteria provided in NuScale DSRS section 12.3, "Radiation Protection Design Feature," provides guidance to the staff for evaluating the potential for airborne radioactivity areas within the facility.

Background

NuScale Design Control Document (DCD) Tier 2 Revision 0, Subsection 12.2.2.1, "Reactor Building Atmosphere," states that airborne radioactivity may be present in the RXB atmosphere due to reactor pool evaporation or primary coolant leakage. The airborne concentration is modeled as a buildup to an equilibrium concentration given the production and removal rate. The airborne concentration in the air space above the reactor pool is determined by using the peak reactor pool water source term. The input parameters are listed in Table 12.2-32 "Input Parameters for Determining Facility Airborne Concentrations." DCD Table 12.2-32 lists the pool evaporation rate at 1705 lbm/hour.

Based on information made available to the staff during the RPAC Chapter 12 Audit, the staff determined that the stated evaporation rate was based on assumed air flow rates over the pool surface, and an assumed temperature of the ultimate heat sink (UHS) water. The staff determined that the NuScale Technical Specifications 3.5.3, "Ultimate Heat Sink," bulk average

temperature limit of 140 ºF was significantly greater than the temperature assumed for determining the evaporation rate. As the pool temperature increases, the pool evaporation rate increases. The assumed pool temperature is not listed in DCD Table 12.2-32.

As stated, the assumed evaporation rate is based on an assumed air flow rate over the pool surface, however, this value is not listed in DCD Table 12.2-32. Also, based on information made available to the staff during the RPAC Chapter 12 Audit, the staff was not able to ascertain the bases of the assumed air flow rate above the UHS pool. It is not clear to the staff what conditions (e.g., ventilation supply and exhaust flow rates etc.) are assumed in order to meet the stated flow conditions.

Based on information made available to the staff during the RPAC Chapter 12 Audit, the staff also noted that the atmospheric conditions (e.g., temperature and humidity) inside of the RXB were inputs to the methodology used by the applicant to determine the evaporation rates. The staff reviewed DCD Section 9.4, "Air Conditioning, Heating, Cooling, and Ventilation Systems," and DCD Section 9.4.2, "Reactor Building and Spent Fuel Pool Area Ventilation System," and was unable to find any reference to the conditions used to establish the assumed evaporation rate.

Key Issue 1:
The DCD does not contain the information necessary for the staff to perform their evaluation of airborne activity as stated above.
Question 1:
To facilitate staff understanding of the application information sufficient to make appropriate regulatory conclusions with respect to radiation exposures, the staff requests that the applicant:

- Revise, as necessary, DCD Table 12.2-32 to include all of the parameters needed to calculate the RXB airborne tritium, and other radionuclide concentrations,
- As necessary revise DCD Sections 9.4.2 and DCD Section 12.2.1.8 to describe the bases for the assumed pool air flow rate,
- As necessary revise DCD Sections 9.4.2 to describe the design features provided for maintaining the required air flow rate over the pool,
- As necessary, revise DCD 12.2.1.8 to describe how this value is to be assessed,

OR

Provide the specific alternative approaches used and the associated justification.

NuScale Response:
During a public NRC clarification teleconference on July 3, 2018, NuScale agreed to provide this supplemental response to RAI 9266 (Q12.02-12) and revise the FSAR to include the input assumptions used for calculating the airborne radionuclide concentrations in the Reactor Building due to reactor pool evaporation.

Impact on DCA:

FSAR Section 12.2.2.1, Section 12.2.3, and Table 12.2-36 have been revised as described in the response above and as shown in the markup provided in this response.

12.2.2 Airborne Radioactive Material Sources

This section describes the airborne radioactive material sources that form part of the basis for design of ventilation systems and personnel protective measures, and also are considered in personnel dose assessment.

12.2.2.1 Reactor Building Atmosphere

RAI 12.02-12S1, RAI 12.02-20

Airborne radioactivity may be present in the RXB atmosphere due to reactor pool evaporation or primary coolant leakage. The airborne concentration is modeled as a buildup to an equilibrium concentration based on Bevelacqua (Reference 12.2-1) given the production rate and removal rate, and on an evaporation rate based on ASHRAE (Reference 12.2-6). The concentration of tritium in the reactor pool water is developed assuming the primary coolant letdown in recycled to the reactor pool. The concentration of tritium in the primary coolant leakage is developed assuming the primary coolant letdown is recycled back to the reactor coolant system. Each case maximizes the tritium concentration in the fluid of interest. These values are reported in Table 11.1-8. The airborne concentration in the air space above the reactor pool is determined by using the peak reactor pool water source term. The input parameters are listed in Table 12.2-36.

$$A(\infty) = (C_{pool} \times p_f \times F_{evap})/(\lambda + (F_{air}/V_{air}))$$

where,

$A(\infty)$ = equilibrium airborne concentration,

C_{pool} = pool water concentration,

p_f = partition fraction,

RAI 12.02-12S1

~~F_{evap} = pool evaporation rate,~~

RAI 12.02-12S1

λ = decay constant, ~~and~~

RAI 12.02-12S1

F_{air}/V_{air} = air change rate, and

RAI 12.02-12S1

F_{evap} = pool evaporation rate = $A/Y(p_w - p_a)(95+0.425V)$,

RAI 12.02-12S1

where,

RAI 12.02-12S1

A = area of pool surface, ft^2

RAI 12.02-12S1

Y = Latent heat of evaporation at surface water temperature, Btu/lb

RAI 12.02-12S1

p_w = saturation vapor pressure at surface water temperature, in. Hg

RAI 12.02-12S1

p_a = saturation vapor pressure at room air dew point, in. Hg

RAI 12.02-12S1

V = air velocity of water surface, fpm.

Primary coolant leaks can occur in the RXB from the CVCS. In areas that are routinely occupied, the RXB heating ventilation and air conditioning system provides sufficient air flow to maintain airborne concentrations to acceptable levels where CVCS leaks are a potential. The airborne concentrations in the RXB cubicles are determined using the same equilibrium model as the reactor pool area, but using CVCS leaks for the production term.

$$A(\infty) = (PCA \times p_{leak} \times p_f \times F_{leak}) / (\lambda + (F_{air}/V_{air}))$$

where,

$A(\infty)$ = equilibrium airborne concentration,

PCA = primary coolant activity concentration,

p_{leak} = leak flashing fraction,

p_f = partition fraction,

F_{leak} = primary coolant leak rate,

λ = radioactive decay constant, and

F_{air}/V_{air} = air change rate.

The resultant airborne isotopic concentrations in the RXB atmosphere are listed in Table 12.2-37. Monitoring airborne radioactivity within the air spaces of the facility is described in Section 12.3.4. Monitoring gaseous effluents is described in Section 11.5.

12.2.2.2 Turbine Building Atmosphere

As discussed in Section 12.2.1.12, the secondary coolant is considered to be clean for normal operating conditions. Therefore, the Turbine Building atmosphere contains minimal airborne radioactive material.

12.2.3 References

12.2-1 Bevelacqua, J.J., *Basic Health Physics, Problems and Solutions*, Wiley-VCH Publishing, Weinheim, Germany, 2004.

12.2-2 International Atomic Energy Agency, "Combined Methods for Liquid Radioactive Waste Treatment" IAEA-TECDOC-1336, Vienna, Austria, February 2003.

12.2-3 Electric Power Research Institute, "Pressurized Water Reactor Primary Water Chemistry Guidelines," Volumes 1 and 2, EPRI 3002000505, Palo Alto, CA, Revision 7, April 2014.

12.2-4 "A Phase Diagram for Jammed Matter," C. Song, P. Wang, H. A. Makse, Nature, 453, 629-632, May 29, 2008.

12.2-5 "Toward the Jamming Threshold of Sphere Packings: Tunneled Crystals," S. Torquato, F. H. Stillinger, Journal of Applied Physics, Volume 102, Issue 9, September 2007.

RAI 12.02-12S1

12.2-6 American Society of Heating, Refrigeration and Air-Conditioning Engineers, 2007 ASHRAE Handbook Applications, Atlanta, GA.

RAI 12.02-12S1, RAI 12.02-20

Table 12.2-36: Input Parameters for Determining Facility Airborne Concentrations

Parameter	Value
Primary coolant leak rate	160 lb/day/unit
Flash fraction of primary coolant leaks	40%
Gas release from primary coolant leaks	100%
Partition coefficients for evaporation and leaks: • Noble gases and tritium • Halogens • Particulates • Iodines (pool evaporation only)	 1 100 200 2000
Primary coolant source term	Table 11.1-4 Table 11.1-8
Pool water source term	Table 12.2-9 Table 12.2-10 Table 12.2-11
Pool evaporation rate: • Pool surface water temperature • Area of pool water surface • Air velocity over water surface • Room air temperature • Room air relative humidity	1705 lb/hour 100°F 11,845 ft^2 30 ft/min 85°F 60%
CVCS pump/valve room leak	~~8~~4 lb/day
Degasifier room leak	~~26~~13 lb/day
Normal ventilation air change rates in RXB: • Pool air space (100' elevation) • CVCS pump/valve rooms (35'-8" elevation) • Degasifier rooms (24' elevation)	 1 air-change/hour 2 air-changes/hour 2 air-changes/hour
Pool air space volume	4.42E+10 ml
CVCS pump/valve room volume	1.12E+08 ml
Degasifier room volume	3.52E+08 ml

12.2.1.14 Other Contained Sources

There are no other identified contained sources that exceed 100 mCi, including HVAC filters. To evaluate the accumulation of radioactive material on the Reactor Building HVAC system HEPA filters, the airborne radioactivity in the Reactor Building due to pool evaporation and primary coolant leaks was deposited on filters assuming a 99 percent particulate efficiency and two years of operation. For the pool evaporation portion, the Reactor Building HVAC system provides a ventilation flow rate equivalent to one air volume change per hour. For the primary coolant leakage portion, the activity that becomes airborne is captured and filtered by the ventilation system. The resultant accumulation of radioactive material is less than 100 mCi.

COL Item 12.2-1: A COL applicant that references the NuScale Power Plant design certification will describe additional site-specific contained radiation sources that exceed 100 millicuries (including sources for instrumentation and radiography) not identified in Section 12.2.1.

12.2.2 Airborne Radioactive Material Sources

This section describes the airborne radioactive material sources that form part of the basis for design of ventilation systems and personnel protective measures, and also are considered in personnel dose assessment.

12.2.2.1 Reactor Building Atmosphere

RAI 12.02-12S1, RAI 12.02-20

Airborne radioactivity may be present in the RXB atmosphere due to reactor pool evaporation or primary coolant leakage. The airborne concentration is modeled as a buildup to an equilibrium concentration based on Bevelacqua (Reference 12.2-1) given the production rate and removal rate, and on an evaporation rate based on ASHRAE (Reference 12.2-6). The concentration of tritium in the reactor pool water is developed assuming the primary coolant letdown is recycled to the reactor pool. The concentration of tritium in the primary coolant leakage is developed assuming the primary coolant letdown is recycled back to the reactor coolant system. Each case maximizes the tritium concentration in the fluid of interest. These values are reported in Table 11.1-8. The airborne concentration in the air space above the reactor pool is determined by using the peak reactor pool water source term. The input parameters are listed in Table 12.2-36.

$$A(\infty) = (C_{pool} \times p_f \times F_{evap})/(\lambda + (F_{air}/V_{air}))$$

where,

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